REMARKS

I. Introduction

By the present Amendment, claims 1-3, 5-7, 11, 13, 18, 20, and 21 have been amended. No claims have been added or cancelled. Accordingly, claims 1-21 remain pending in the application. Claims 1-3, 5-7, 11, 13, 18, 20, and 21 are independent.

II. Office Action Summary

In the Office Action of January 11, 2007, claims 1-12, 20, and 21 were rejected under 35 USC §103(a) as being unpatentable over U.S. Patent No. 6,980,846 issued to Hardy et al. ("Hardy") in view of U.S. Patent No. 6,687,528 issued to Gupta et al. ("Gupta"). Claims 13-19 were rejected under 35 USC §103(a) as being unpatentable over Hardy in view of Gupta, and further in view of U.S. Patent No. 5,668,474 issued to Held. These rejections are respectfully traversed.

III. Interview

Applicants would like to thank Examiners Cheng and Mantis-Mercader for the cooperation and courtesy extended during the interview conducted on April 4, 2007. During the interview, Applicants discussed various differences between the claimed invention and the references to Hardy and Gupta. In particular, it was noted that Hardy performs a two-dimensional cross correlation, which is not performed in the instant invention. It was indicated that the relevance of not performing a two-dimensional cross correlation was not apparent in the claims. No agreements were reached concerning specific claim language that would place the application in condition for allowance.

Claims 1-12, 20, and 21 were rejected under 35 USC §103(a) as being unpatentable over Hardy in view of Gupta. Regarding this rejection, the Office Action alleges that Hardy discloses a method for acquiring image data from a subject using an MRI system. The Office Action indicates "in particular, Hardy et al. discloses an MRI system that acquires a reference data set of a region of interest, such as the motion of the heart or heart beat (col. 1, lines 27-33), and then acquires a plurality of free-breathing data sets of this region of interest. The free-breathing data sets are then compared with the reference data set to be used in creating an image of the region of interest (col. 1, lines 60-67)." The Office Action further alleges that Hardy performs a comparison between the reference and free-breathing images through cross-correlations in order to decide which images should be kept and which ones should be thrown away. If a feature of interest is present in any of the free breathing images, then the cross-correlation would reveal a strong central peak. Otherwise, the central peak would be offset.

The Office Action admits that Hardy does not expressly disclose setting a threshold to determine which images to reject, but concludes that some sort of threshold is inherently necessary in order to reject any of the images. The Office Action further admits that the comparison is not performed using a similarity coefficient, but concludes that the results of similarity coefficients and the cross-correlation are the same. Gupta is further relied upon for showing the use of correlation coefficients in order to determine images to be used based on a cut-off value. Applicants respectfully disagree.

By the present Amendment, Applicants have revised the instant claims to better clarify the invention and identify the features that are not shown or suggested by the art of record. According to independent claim 1, for example, an inspection

apparatus is provided using nuclear magnetic resonance. The inspection apparatus includes a controller that controls a pulse sequence that applies a radiofrequency magnetic field and a magnetic field gradient to a living body that has been placed in a static magnetic field in order to determine a nuclear magnetic resonance signal produced from the body. In order to achieve this result, the controller performs the following functions. First, in a state where the body is not exhaling or inhaling, the controller controls a first pulse sequence to detect the nuclear magnetic resonance signal and acquire a reference projection of an imaging section for monitoring the respiratory motion of the body. Next, during breathing, the controller controls execution of one of the first pulse sequence to detect the nuclear magnetic resonance signal and acquire a projection of the imaging section to monitor the state of the body during breathing. The controller further repeats a second pulse sequence to detect the nuclear magnetic resonance signal to acquire an image of the imaging section at predetermined repetition time intervals. Finally, the controller collects the nuclear magnetic resonance signals to reconstruct an image of the imaging section in the second pulse sequence based on a similarity coefficient between the projection and the reference projection. Further, according to independent claim 1, the similarity coefficient is in the form of a scalar value.

According to the arrangement of independent claim 1, the similarity coefficient is a scalar, thereby significantly reducing the amount of time and computation required to perform the comparisons and reconstruct the image. Accordingly, it is possible to perform a greater number of comparisons to improve image reconstruction. It is noted that Figs. 4 - 7, for example, describe the manner of obtaining a reference projection and the projection, with Fig. 6(C) illustrating obtaining of the similarity coefficient. As is apparent, the similarity coefficient is

scalar, and the time for calculating the similarity coefficient is short, which results in shortening of the processing time without giving any load to a subject or living body to be inspected. The specification describes the obtaining of the similarity coefficient which is utilized, as described in connection with Fig. 6(C) at page 28, lines 18 - 27 of the specification, and the graph of the linear correlation coefficients (similarity coefficients) in Fig. 6(C) shows the result of a moving average of 15 linear correlation coefficients, and from the graph, the change in the linear correlation coefficient in synchronization with breathing of a subject can be read, whereby the linear correlation coefficient is close to 1 at exhalation, and is smaller at inspiration, whereby respiratory motion of the subject can be monitored using the linear correlations. As described at page 30 of the specification in connection with Fig. 7, which shows an actual pulse sequence, and in connection with Fig. 8, a reference projection is acquired, Rth is calculated and a similarity coefficient is calculated, whereby when the similarity coefficient is larger than Rth, echoes are acquired.

The Office Action alleges that Hardy discloses various features of the claimed invention, and that no significant differences have been shown between a one-dimensional or two-dimensional cross-correlation. Contrary to this assertion, however, Applicants submit that the similarity coefficient of the instant invention differs from that disclosed in Hardy. At the outset, Applicants note that Hardy does not perform a comparison using similarity coefficients. Hardy performs a comparison that utilizes two-dimensional cross-correlation. As discussed in column 4, "each spiral interleaf of the breath-held data set is reconstructed into a separate complex (n-phase and quadrature, or I and Q) image, hereinafter referred to as reference or breath-held sub-images to form a reference or cross-correlation kernel." See lines 17-10. Hardy further explicitly indicates that the comparison between the

reference and free breathing interleaves is desirably accomplished through the use of two-dimensional cross-correlation. See column 5, lines 11-42. Hardy goes on to indicate that a set of cross-correlation kernels is generated in each of the breath-held or reference sub-images and the cross-correlation kernels are then cross-correlated with each of the corresponding free-breathing sub-images.

As described, in practice, the cross-correlation is desirably done by multiplication in the Fourier domains (by use of the correlation theorem) in order to speed up the computation by as much as several orders of magnitude. Then, if the feature of interest is present in any of the free-breathing sub-images, then the cross-correlation will reveal a strong central peak (column 5, lines 10 - 25). Thus, Hardy et al discloses a comparison of images via computation of two-dimensional information, whereas the present invention controls the process based on a similarity coefficient between the projection and the reference projection, which similarity coefficient is based upon a scalar value. Irrespective of the contentions made by the Examiner, Hardy et al does not disclose or teach the recited features of the independent and dependent claims of this application, wherein a similarity coefficient is determined between the projection and reference projection which achieves a shortening of processing time.

The Examiners had indicated, during the interview, that Hardy utilizes the kernels as a reference to be cross-correlated against. Further, it was suggested that a two-dimensional cross-correlation would result only if there were no matches. If a match were made, then the resulting cross-correlation would be one-dimensional. Even if such were the case, which Applicants disagree with, the resulting one-dimensional correlation is still in the form of vector containing multiple values along one dimension. This differs from the similarity coefficient recited in independent

claim 1, which is actually in the form of a scalar value, and not a vector or array. Accordingly, the resulting comparison would still require greater computation and time than that recited in independent claim 1.

The Examiner contends that Gupta discloses a correlation that can be combined with the teachings of Hardy. This does not appear to be the case. Gupta provides a system wherein a number of images are combined to generate a relaxation-time image using a pixel-by-pixel fixed curve fitting algorithm. Gupta identifies correlation coefficient cut-offs to minimize the inclusion of vessel voxels. The correlation coefficient of Gupta, however, is merely a value that relates to the accuracy of the curve fitting algorithm, and has absolutely no bearing or relationship to a cross-correlation such as described in Hardy. Hardy clearly indicates that "a number of known techniques can be used to register the successive high contrast images, including pattern matching techniques such as cross-correlation and least squares methods." See column 5, lines 48-52. Clearly, the correlation coefficient of Gupta is not used as a cross-correlation technique for comparing the different images. The combination of Hardy and Gupta simply fails to provide any disclosure or suggestion for all the features recited in independent claim 1, such as utilization of a scalar valued similarity coefficient in reconstructing the images.

It is therefore respectfully submitted that independent claim 1 is allowable over the art of record.

The remaining independent claims (2, 3, 5-7, 11, 13, 18, 20, and 21) all recite the feature of the similarity coefficient being a scalar. Accordingly, these claims are also believed to be allowable over the art of record.

Likewise, the dependent claims are believed to be allowable for at least the reasons set forth with respect to the independent claims.

IV. Conclusion

For the reasons stated above, it is respectfully submitted that all of the pending claims are now in condition for allowance. Therefore, the issuance of a Notice of Allowance is believed in order, and courteously solicited.

If the Examiner believes that there are any matters which can be resolved by way of either a personal or telephone interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

Docket No. 520.42912X00
Serial No.10/614,019
Office Action dated January 11, 2007

AUTHORIZATION

Applicants request any shortage or excess in fees in connection with the filing of this paper, including extension of time fees, and for which no other form of payment is offered, be charged or credited to Deposit Account No. 01-2135 (Case: 520.42912X00).

Respectfully submitted,
ANTONELLI, TERRY, STOUT & KRAUS, LLP.

Leonid D. Thenor
Registration No. 39,397

LDT/vvr
1300 N. Seventeenth Street
Suite 1800
Arlington, Virginia 22209
Tel: 703-312-6600
Fax: 703-312-6666

Dated: May 11, 2007